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(57) **Abstract**

For a fastening arrangement for fastening accessories to ophthalmic devices – in particular spectacles – by means of permanent magnets, it is suggested that the latter have high magnetic characteristic values, such as energy density and remanence, through the use of alloys containing at least one rare earth element and / or cobalt and /or by making them

magnetically anisotropic and thereby keeping the volume and weight of the permanent magnets very small, which is advantageous for mounting them in spectacle frames, while ensuring at the same time that the accessory is reliably fastened.

(57) Abstract

For a fastening arrangement for fastening accessories to ophthalmic devices – in particular spectacles – by means of permanent magnets, it is suggested that the latter have high magnetic characteristic values, such as energy density and remanence, through the use of alloys containing at least one rare earth element and / or cobalt and /or by making them magnetically anisotropic and thereby keeping the volume and weight of the permanent magnets very small, which is advantageous for mounting them in spectacle frames, while ensuring at the same time that the accessory is reliably fastened.

Fastening Arrangement

The present invention concerns a fastening arrangement in accordance with the preamble of Claim 1.

Ophthalmic devices serve essentially to protect the eyes – in part, too, the eye region and the face – to correct vision problems, and to produce esthetic effects.

Often, the user desires that an ophthalmic device fulfill several functions of this kind.

A particularly important example is the case of an ophthalmic device designed as corrective spectacles, which – at least, in part – are also intended to assume the function of anti-glare spectacles.

Solutions are known in which anti-glare glasses are placed as an accessory part in the optical path of the light rays, in particular by fastening anti-glare spectacles, as an accessory part, to corrective spectacles in a detachable manner. In one of these solutions, the anti-glare glasses, while fastened, can be flipped into and out of the path of the light rays. Especially disadvantageous in these solutions is the purely mechanical way in which the accessory part – in this case, the anti-glare glasses or spectacles – is fastened to the ophthalmic device in the form of corrective spectacles. In particular when a gripping and spring mechanism is used, this means that, in the mounted state, the arrangement is unpleasantly bulky, gets caught in pieces of clothing, and, moreover, largely destroys the original esthetic effect of the spectacles, something that is felt to be especially unpleasant.

In contrast to this, it was proposed to fasten accessory parts – in particular, as glare protection or as supplemental lenses with positive refractive power in the lower part of the spectacles lenses or as decorative elements – to spectacles in a detachable manner by means of permanent magnets (DE-OS 17 97 366, FR 9 15 421, GB 8 55 268, US 2,737,847). With regard to the permanent magnets, the use of high-coercivity permanent magnetic material was proposed (DE-OS 17 97 366) [OS = published unexamined patent application].

This manner of fastening accessories to spectacles by means of permanent magnets and their forces of attraction (forces of adhesion) makes it possible, in a simple, fast, and reliable way that largely avoids impediments, dangers, and inconveniences to the user, to bring optically active parts of accessories into the visual path of the light rays – and back out of the visual path of the light rays – and also makes it possible to fasten to spectacles, in a detachable manner, other accessories that are situated largely outside of the visual path of light rays. In addition, the original esthetic effect of the spectacles can be retained to the greatest possible extent owing to the absence of bulky mechanical fastening elements. Nonetheless, the market introduction of spectacles with accessories fastened by means of permanent magnets has so far failed in practice.

The reason for this is to be seen mainly in the fact that special requirements are placed on fastening arrangements for fastening accessories to ophthalmic devices – in particular,

spectacles – these requirements being, in particular, a small, organically and esthetically well-adapted size, both in itself and in its form in the spectacle design, a small volume and weight, and a high acceleration resistance and thus reliability of fastening and resistance to corrosion. These requirements can only be fulfilled by a special design of the permanent magnets.

The object of the present invention is to design permanent magnets in connection with ophthalmic devices – in particular, spectacles – and accessories in such a way that a fastening arrangement for fastening of the accessory to the ophthalmic device – in particular, spectacles – is created, this fastening arrangement satisfying, to the largest extent possible, the above-mentioned special requirements that are to be placed on fastening arrangements and making it possible, for a modular, systematic series of ophthalmic devices – in particular, spectacles – and accessories, to bring optically active regions of accessories into the visual path of the light rays – and back out of the visual path of the light rays – in a simple, fast, and reliable way that avoids, to the greatest extent possible, impediments, dangers, and inconveniences to the user and also making it possible to fasten in a detachable manner to ophthalmic devices – in particular, spectacles – other accessories that are situated essentially outside of the optical path of the light rays. In the process, the original esthetic effect of the ophthalmic device should be retained to the greatest extent possible.

The attainment of this object occurs through the characteristic features of Claim 1. The subclaims contain advantageous embodiments of the invention.

In investigations and tests carried out in the framework of the present invention, it was found that considerable accelerations a can act on an accessory part that is fastened to an ophthalmic device – in particular, spectacles – during use. These are brought about especially often by strong movements of the body and head. Acceleration values that are even higher than those caused by strong movements of the body and head can occur through strong hand movements with, for example, spectacles and, above all, when, for example, an ophthalmic device – in particular, a pair of spectacles – is laid down hard on a table top or a similar object.

It has been shown that acceleration values of up to approximately 5 g (g = acceleration due to gravity) and, in many cases, even up to approximately 10 g can be expected. The force acting on an accessory part of mass m is $K = ma$. Accordingly, a mass m of, for example, 0.025 kg and an acceleration a of, for example, 5 g results in a force K of about 1.25 Newton (N) acting on the accessory part; an acceleration a of 10 g results in a force K of 2.5 N.

Employed initially in the investigations and tests carried out in the framework of the present invention were two permanent magnets, which lie opposite each other with opposite polarity and which are each firmly attached to an ophthalmic device – in particular, spectacles – or to an accessory part and between which a force of attraction (force of adhesion) F exists, by means of which the accessory part is fastened to the ophthalmic device – in particular, spectacles. Here, the force F – in the sense of

acceleration resistance and thus reliability of fastening and thus in the sense of the object posed – should at least compensate for the force K arising through acceleration; that is, in terms of magnitude, $F \geq K$.

Fig. 1 shows schematically the permanent magnets referred to here by 034 and 036, further parts being omitted for reasons of clarity. Their opposite polarity is indicated arbitrarily by being marked with N and S. The permanent magnets 034, 036 are magnetized over the dimension L1, L2. In Fig. 1a, the two permanent magnets 034 and 036 are depicted schematically in the fastened state, that is, when the accessory part is fastened to the ophthalmic device, and, in Fig. 1b, in the unfastened state, that is, when the accessory part is unfastened from the ophthalmic device.

In the fastened state, when the width h of the gap 035 between the permanent magnets 034 and 036 is small in comparison to the total length $L = L1 + L2$, the following equation approximately holds for the force of attraction (force of adhesion) F between the two permanent magnets 034 and 036: $F = 4 \times 10^5 \times f \times B_A^2$ (f = cross-sectional area of the permanent magnets, B_A = induction of the permanent magnets in the fastened state corresponding to operating point A of their demagnetization curves).

Together with the initial requirement stated, namely, $F \geq K$, this results in the following requirement for the induction of the permanent magnets 034 and 036: $B_A \geq 1.6 \times 10\text{-}3$ $\sqrt{K/f}$.

The permanent magents 034 and 036 can, for example, be cylindrical - which is especially advantageous in terms of production technology both with respect to their manufacturing and their later installation in ophthalmic devices (in particular, spectacles) or accessories - with, for example, equal diameters D (Fig. 1), and lengths L1 and L2 (Fig. 1), which for example can be equal.

The investigations and tests carried out in the framework of the present invention have shown that, for example, cylindrical permanent magnets 034, 036 with a diameter of about 4 mm can still be incorporated into ophthalmic devices - in particular, spectacles - and accessories, with the fastening arrangement formed in this way fitting organically and esthetically into the spectacle design with respect to their shape and - small - size, and in particular they do not noticeably disturb the spectacle or accessory wearer either with extra volume or extra weight.

The diameter, for example, of about 4 mm results in a cross section area f of about 1.2×10^{-5} m^2. From the requirement given above, namely, $B_A \geq 1.6 \times 10^{-3} \sqrt{K/f}$, there results an induction for the permanent magnets 034, 036 of the fastening arrangement in the fastened state (Fig. 1a) with an accessory part mass m of, for example, 0.025 kg and an acceleration of, for example, a = 5 g with the corresponding force F of 1.25 N, the instruction $B_A \geq 0.5$ Tesla (T) for the design of the permanent magnets 034, 036 and, for an acceleration of, for example, a = 10 g with an associated force K of 2.5 N, the requirement $B_A \geq 0.7$ T for the design of the permanent magnets 034, 036 for increased acceleration resistance –

corresponding to the increased acceleration value of 10 g – and fastening reliability of the accessory parts to the ophthalmic device, particularly spectacles.

In the preferred cylindrical-shaped design, for example, of the permanent magnets 034, 036, there are no limitations. On the contrary, in the investigations and tests carried out in the framework of the present invention, the permanent magnets 034, 036 were successfully tested also as rectangular bodies with, for example, dimensions of 3 x 3.5 x 5 mm^3 – magnetized through the dimension 3, for example, in fastening the accessory parts to ophthalmic devices – in particular, spectacles.

Fig. 2 schematically shows a demagnetization curve 01 of permanent magnets, such as, for example, 034 and 036. Plotted along the abscissa is, as generally common for permanent magnets, the demagnetizing field $H = - NJ/\mu_o$ (N = demagnetization factor, known to be $0 \leq N \leq 1$, J = polarization, μ_o = induction constant); plotted along the ordinate is the induction B.

Because of the high B_A values required, as discussed above, the permanent magnets 034, 036 must have very high values of the remanence B_r, these values lying above B_A, and the demagnetization curve 01 should be as flat as possible. The latter requirement holds all the more as the angle [alpha] of the operating straight lines 02 is relatively large on account of cotg [alpha] = (1-N) / N owing to the high demagnetization factor N, which lies, for example, above 0.3 and is due to a small L/D ratio (Fig. 1a). The ratio L/D therefore has a small value, because, in terms of the object posed, not only must the thickness or the diameter D be kept small – that is, in the range of several millimeters – but also the lengths L1 and L2 or the length L = L1 + L2 of the permanent magnets 034, 036, which, in the fastened state (Fig. 1a), may be regarded in approximation as a single permanent magnet.

For a flat course of the demagnetization curve 01, it is necessary that the curve $B = (BH)_{max} / H$, referred to by 04, touch the demagnetization curve at a B value that is as high as possible, for which reason permanent magnets, such as 034, 036, should exhibit high values of the maximal energy product or the energy density $(BH)_{max}$ (quality characteristic).

In addition to this, the demagnetization curve, as shown in the schematic depiction of Fig. 2, should be, to the greatest extent possible, practically a straight line, on which the operating point P of the individual permanent magnets, such as 034, 036, should also lie in the unfastened state (Fig. 1b). In this way, it is possible to ensure that, on repeated fastening and unfastening of accessory parts or of permanent magnets, the operation is performed on the straight section of the demagnetization curve 01 between the operating points A and P and, in this way, no loss of magnetization to lower B values results.

The operating straight line 03, which determines the operating point P, lies at an angle ß, which is given by cotg ß = (1-N) / N, whereby the demagnetization factor N is now

determined by the ratio L1/D or L2/D, which is lower than L/D, and is correspondingly increased.

In extension of the investigations and tests carried out in the framework of the present invention, it resulted that the requirements thereby worked out and discussed above with respect to the permanent magnets, such as, for example, 034, 036, can only be observed by means of their special design described below.

In order to attain the high values of the induction B_A or the remanence B_r and of the energy product or the energy density $(BH)_{max}$ in accordance with the requirements, the permanent magnets, such as, for example, 034, 036, should be made of alloys, in themselves known, that contain at least one rare earth element and / or cobalt, such as, for example, samarium-cobalt, neodymium-iron-boron, lanthanum-cobalt, yttrium-cobalt, cerium-cobalt, and praseodymium-cobalt alloys and mixtures thereof as well as of alloys containing at least aluminum, nickel, and cobalt (AlNiCo alloys). Especially high values of the remanence B_r and of the energy product or energy density $(BH)_{max}$ may be attained if the permanent magnets, such as 034, 036, of the fastening arrangement are designed with a magnetic anisotropy, so that they exhibit a preferred axis for the magnetic polarization J, whereby the high values of the stated magnetic properties are attained in this preferred axis upon magnetization, that is, when the magnetic polarization J lies in this axis.

The magnetic anisotropy and the preferred axis associated with it are created in a way that is itself known during the manufacture of the permanent magnets, such as 034, 036, of the fastening arrangement, for example by treatment with a magnetic field and / or heat, by pressing of powdered starting material in a magnetic field before sintering, or by cooling of the hot magnets in a magnetic field.

The operating points A and P of the permanent magnets, such as 034, 036, of the fastening arrangement may be shifted in an advantageous way, which increases the force of adhesion and the reliability, in the direction of higher B values if the permanent magnets are designed with a soft magnetic keeper 046 and 048 for the magnetic flux, as depicted schematically in Fig. 3, whereby the demagnetization factor is reduced. This design is appropriate for AlNiCo magnets, in particular, since their demagnetization curve – starting from high values of the remanence, which can lie above 1 T – falls off relatively steeply. The permanent magnets, in this case, are advantageously magnetized after being placed – if necessary, once again – in the keeper.

For the investigations and tests carried out in the framework of the present invention, the dependence of the force of attraction (force of adhesion) F between two oppositely poled permanent magnets, magnetized over the length L1, L2, was measured as a function of their mutual separation h (Fig. 1a). The result for two cylindrical permanent magnets 034, 036, for example, which had diameters of, for example, about 4 mm and lengths L1 and L2 of about 3 mm each – that is, L/D = 1.5 – and were made of a samarium-cobalt alloy with a $(BH)_{max}$ of about 170 KJ / m^3 and a remanence B_r of about 0.95 T as well as a

coercivity field strength HC of about 640 kA / m, is shown in Fig. 4. The force F, calculated according to the formula given above, is also plotted, marked with x, and is in good agreement, in terms of practice, with the measurement. An increase, for example, of L1 and L2 to about 6 mm – that is, L/D = 2.25 and 3 – resulted, in each case, in an advantageous increase in the value of the force value by approximately 20%. A decrease, for example, to about 2 mm – that is, L/D = 1.25 and 1 – resulted in a lowering, in each case, by about 15%, which is acceptable for very light accessories.

In accordance with Fig. 4, it was found that the force F initially decreases only slightly with increasing separations h, so that, for small separations h – about 0 to 0.3 mm – the value of the force F for h = 0 can be taken in practice. Furthermore, it resulted (Fig. 4) that, for the allowable force K = F of 2.5 N – corresponding to an acceleration a of 10 g for an accessory part mass m of 0.025 g (increased reliability) – h may amount to approximately 0.4 mm; for the reliable force K = F of 1.25 N – corresponding to an acceleration a of 5 g for an accessory part mass m of 0.025 g – it may amount to approximately 1 mm. As result of the force measurements, there results the design requirement that the separation h of the permanent magnets 034, 036 in the fastened state, that is, when the accessory part is fastened to the ophthalmic device – in particular, a pair of spectacles – in a detachable manner by means of magnets, should not be greater than approximately 1/6 of the total length of the magnet, L = L1 + L2.

This design requirement must be particularly observed when the permanent magnets 034, 036 are mounted in a capsulelike manner as housings 010, 011, designed as shells or cases (Fig. 5), as will be described below, whereby, in this case, the smallest possible separation h is governed by the thicknesses B10 and B11 of the bottom of the cases 010, 011. Schematically shown in Fig. 6 on the basis of two sample embodiments, which were worked out in the investigations and tests in the framework of the present invention, is the extremely spatially economical way, in terms of the object posed, in which the cylindrical permanent magnet 034, for example, which has a diameter D of about 4 mm and a length L1 of about 3 mm and is made of, for example, a samarium-cobalt alloy with, for example, a $(BH)_{max}$ of about 170 KJ / m^3, which, together with an identical permanent magnet 036 in the accessory part, which is not depicted, affords the considerable force of adhesion of approximately 3 N, can be placed in, for example, metal spectacle frames.

It has been found that, in particular for accessory parts with relatively small mass m, it is also possible to successfully employ rare earth alloys, in particular samarium-cobalt alloys, which are very advantageous in terms of resistance to corrosion, with $(BH)_{max}$ values less than 170 KJ / m^3 – for example, about 140 KJ / m^3 – in the fastening arrangement, whereby the remanence B_r of such alloys can lie at, for example, 0.85 T. Advantageous for particularly heavy accessory parts are permanent magnets with $(BH)_{max}$ values above 170 KJ / m^3, such as those made of a neodymium-iron-boron alloy, which can be provided advantageously with corrosion-protection agents, such as, for example, lacquer layers, whereby the remanence B_r of such alloys can lie at, for example, about 1.1 T and $(BH)_{max}$ can lie at, for example, 230 KJ / m^3. The values of the coercivity

field strength HC of the above-mentioned rare earth alloys lie, for example, above about 600 kA / m.

In the sample embodiment in accordance with Fig. 6a, the permanent magnet 034 – firmly attached with adhesive or molded in plastic, for example, and thus superbly protected against corrosive influences – is situated in a capsulelike housing 010 designed as a shell or case, which, preferably, is soldered into the region of the bridge 016 in the spectacle frame 06 and, in addition, protects the permanent magnet 034 against mechanical damage and corrosive influences. In the sample embodiment in accordance with Fig. 6b, the permanent magnet 034 is mounted in a pocketlike extension 07 of a bridge 017, designed, for example, as a molded and / or stamped metal bar 08, of a metal spectacle frame 09.

The invention will be described in greater detail below for sample embodiments on the basis of additional schematic drawings.

The drawings show the following:

Fig. 1 permanent magnets of a fastening arrangement

Fig. 2 the demagnetization curve with the operating points A and P of an ensemble of two permanent magnets of a fastening arrangement

Fig. 3 permanent magnets with a keeper for the magnetic flux

Fig. 4 dependence of the force F, utilized in the fastening arrangement between two permanent magnets, on their mutual separation h

Fig. 5 permanent magnets in capsulelike housings designed as shells or cases

Fig. 6 metal spectacle frames with permanent magnet

Fig. 7 a pair of corrective spectacles with fastened light shades

Fig. 8 to Fig. 11 magnet systems of the fastening arrangement

Fig. 12 corrective spectacles with fastened corrective attachment

Fig. 13 corrective spectacles with fastened corrective attachment or corrective and light-shade attachment

Fig. 14 an auxiliary device for attachment of spectacles and / or accessory parts

Fig. 15 corrective spectacles with fastened protective part

Fig. 16 ski goggles with fastened light shades

Fig. 17 diving goggles with fastened corrective attachment

Shown schematically in Fig. 7, as sample embodiment for an ophthalmic device with an accessory part fastened to it, is a pair of corrective spectacles 2 with rims 4 and 6, highlighted in bold lines for clarity, hinge tabs 8 and 10, skull temples 12 and 14, bridge 16, glasses or lenses 18 and 20, and, fastened to the corrective spectacles, light shades 22 that are transparent and subdue light at least in the region of the visual path of light rays. The top part of Fig.7 shows a front view, the bottom part a section A-A. The light shades 22 serve to protect the eyes against, in particular, glare and / or irritation, whereby the protection can also involve nonvisible regions of light, in particular, for example, the ultravioletregion.

The fastening itself occurs by means of two permanent magnets, 34 and 36, each of which has a practically uniform, mutually opposite polarity (indicated by schematic marking with N and S), which are held together by the force of adhesion existing between them, whereby the permanent magnet 34 is situated firmly in the bridge 16 and the permanent magnet 36 is situated firmly in the connecting part 28 that supports the optically active regions 30 and 32 of the light shades 22. It is especially advantageous for the regions 30 and 32 and the connecting part 28 to be manufactured as a plastic part by injection molding, whereby the permanent magnet 36 can be co-molded as well at least in part. For example, the regions 30 and 32 can also be manufactured in conjunction and the permanent magnet 36 can be fastened to the light shades 22 directly, for example through adhesive. Furthermore, the permanent magnet 36, as well as the permanent magnet 34, can consist of several individual magnets in order, for example, to counter the risk of possible breakage due to mechanical stress placed on the light shades 22 or the corrective spectacles 2.

The bridge 16 and the connecting part 28, with their permanent magnets 34 and 36, serve, at the same time, as support for an accessory part in the form of the light shades 22, whereby, as a special means, the angled pieces 42 and 44 – which can also be oriented or designed differently and, in particular, for example, can allow an at least partial gripping or molded clamping of the connecting part 28 in the upper and / or lower, nondepicted region of the bridge 16 as well – are intended to make possible a self-adjusting fastening and to ensure a firm sit.

The mounting of the permanent magnet 34 in the bridge 16, in accordance with the sample embodiment of Fig. 7, does not represent any limitation. On the contrary, the permanent magnet 34 and / or at least one other corresponding permanent magnet can also be placed in a different site of the corrective spectacles 2, for example above the position depicted in Fig. 7 for the permanent magnet 34 – for example, in a widened portion of the bridge 16 or in an additional, bracelike connection between the rims 4 and 6 in the region of the bridge 16 and / or, for example, in the rims, for example in the region of the hinge tabs 8 and 10 or, for example, in the hinge tabs 8, 10 themselves. The permanent magnet 36 and

/ or at least one other corresponding permanent magnet of the light shades 22 is then situated opposite to at least one permanent magnet of the corrective spectacles 2 in a corresponding position to that of the light shades 22 (not depicted). This holds in a corresponding manner for the keeper parts 50 and 51 discussed below.

Since the permanent magnets 34 and 36 each exhibit a large demagnetization factor due to their shape, it is very particularly advantageous, in order to attain high magnetization values in the permanent magnets and – associated therewith – high values of the magnetic charges or pole strengths producing the force of adhesion on their outer surfaces that act as poles, to use – as permanent magnets 34, 36 – permanent magnets that, for example, are each provided during their fabrication with a preferred axis 38, 40 for the magnetization – for example, by treatment with a magnetic field and / or heat, that is, permanent magnets that are magnetically anisotropic and thus exhibit a magnetic anisotropy. The preferred axes 38, 40 of the permanent magnets 34, 36 are preferably roughly parallel to each other in the way depicted in Fig. 7 in section A-A, for example, or as depicted next to this on the right in the partial depiction of the permanent magnets 34, 36, for example.

Suitable as material for the permanent magnets 34, 36 are, quite especially, magnetic materials that contain at least one rare earth element or at least one rare earth element and boron, such as, for example, alloys containing at least cobalt and samarium as well as alloys containing at least neodymium, iron, and boron.

Such alloys exhibit, in particular, a favorable demagnetization curve with high values of the coercivity field strength and the magnetic energy density, so that, even with low-volume permanent magnets 34, 36, high forces of adhesion are attained. When the magnetic substances mentioned are used in the design, the low volumes of the magnets 34, 36 extremely facilitates their mounting in the bridge 16 or in the connecting part 28 and makes possible, in a very advantageous way, particularly small-volume bridges 16 and connecting parts 28.

As the decisive physical factor governing the fastening arrangement, the force of adhesion can be increased still further or the volume of the permanent magnets decreased – the latter being particularly cost-effective – if the permanent magnet 34 and the permanent magnet 36 each have a keeper 46 and 48, respectively, in the form of a so-called pot magnet, for instance, for at least partial absorption of the magnetic flux passing through each of the permanent magnets and emerging from them, in such way that, as highlighted schematically in Fig. 8a, the more favorable working points on the demagnetization curves of the permanent magnets are reached.

Fig. 8b and Fig. 8c schematically show sections through two constructions, given by way of example, of the permanent magnet 34 with a keeper 46 in the bridge 16, which, also holds in a like manner when extended, as sample embodiment, to the permanent magnet 36 with its keeper 48 of the connecting part 28.

In many cases, in particular when a magnetic material with especially high coercivity field strength and energy density is employed for the permanent magnets, it is sufficient if the keeper 46 only partially surrounds the permanent magnet 34 or the keeper 48 only partially surrounds the permanent magnet 36, for example in a U-shaped manner, as evident from the scheme of Fig. 8b, so that, in addition, an especially narrow bridge 16 is made possible. An especially high force of adhesion is attained when the keeper 46 surrounds the permanent magnet 34 from the side or when the keeper 48 surrounds the permanent magnet 36 from the side, as evident from the scheme of Fig. 8c.

In many cases, in particular when the accessory part – namely, the light shades 22 in the case of Fig. 7 or Fig. 8 – has a relatively low weight, it is sufficient if only one permanent magnet, 34 or 36, is furnished with a keeper, 46 or 48, respectively. In these cases, it is often even sufficient if a fastening arrangement has only one permanent magnet – for instance, in the case of the sample embodiment corresponding to Fig. 7 or Fig. 8, the bridge 16 has the permanent magnet 34 or the connecting part 28 has the permanent magnet 36 – and, in place of one of these permanent magnets, a keeper part is present for at least partial absorption of the magnetic flux passing through each of the permanent magnets and emerging from them, in such a way as is depicted schematically by way of example in Fig. 9 for the bridge 16 with a keeper part 50 in connection with the connecting part 28 with the permanent magnet 36 with a keeper 48.

Satisfactory for, above all, especially light accessory parts – for example, especially low-weight light shades 22 – is a modified, simple fastening arrangement corresponding to the sample embodiment of Fig. 10. Here, in comparison to the arrangement corresponding to Fig. 9, a permanent magnet 52, which has segments of different polarity, has taken the place of the permanent magnet 36 with its keeper 48, in such a way as is intended to be made evident by means of the schematic marking with N and S in Fig. 10 as sample embodiment with a two-sided, multipole magnet 52, whereby this sample embodiment does not signify any limitation in terms of the possible polarity distributions.

A permanent magnet 54 with sectors of alternating polarity can also be situated in the bridge 16, while a permanent magnet 53 is in the connecting part 28 (Fig. 11) or a keeper part 51, corresponding to a keeper part 50, is situated in the connecting part 28 (not depicted).

The different possible embodied forms of the magnet systems within the fastening arrangement for accessories to ophthalmic devices make it possible to realize an optimal solution in a very advantageous manner for each case of an accessory part or an ophthalmic device, particularly when the possibilities with respect to the choice of magnetic materials are also included.

Preferably when the accessory part – for example, the light shades 22 – has a relatively low weight and the permanent magnet 34 is provided with the keeper 46 and / or the permanent magnet 36 is provided with the keeper 48, it is also possible, in a manner that is advantageous, above all, in terms of cost, to employ magnetic materials with lower values of the coercivity field strength and the energy density than those already

mentioned for the permanent magnets 34 and 36, for example magnetic materials than contain cobalt, in particular in alloys, and that, beyond this, have at least aluminum and nickel as components (AlNiCo).

In many cases in which, for example, a particularly formal accommodation of the permanent magnets is required, the use of magnetic substances – in particular, for example, the magnetic materials mentioned in the preceding discussion, which are favorable in terms of cost – that are embedded in natural rubber and / or plastic is especially advantageous owing, in particular, to their good workability. It is advantageous, above all in terms of fabrication techniques, to construct large regions from such materials; that is, for example, large regions of the connecting part 28 or the entire connecting part 28 can be made from particles of an alloy containing cobalt and samarium embedded in natural rubber or particles of an alloy containing neodymium, iron, and boron embedded in plastic.

Moreover, owing, above all, to their relatively good workability, cobalt alloys with at least the addition of iron and vanadium, with at least the addition of iron and chromium, with the addition of iron, nickel, titanium, and / or niobium, and with platinum are also of advantage in specific applications. The cobalt-platinum alloys, in particular, exhibit high values of the coercivity field strength and of the energy density, which increase the force of adhesion and reduce the volume, these materials being characterized by a particularly low brittleness, which is conducive to their workability, and being extremely resistant to corrosion by practically all corrosive media. Cobalt alloys with addition of iron and nickel are suitable, in particular, also for fusing in glasses, for example as permanent magnets in contact lenses, which, for example, can be fastened individually to an ophthalmic device by means of these permanent magnets.

The keeper 46 or 48 and the keeper part 50 or 51 is made preferably of iron, whereby, in particular in terms of corrosion protection and in an economically advantageous way, this iron must not involve high-purity iron; that is, the iron can contain additives. For reasons of corrosion protection, in particular, the iron is preferably furnished, in addition, with one or more protective layers and / or injection-molded with a coat of plastic material.

The choice of material for the keeper 46 or 48 and for the keeper part 50 or 51 is not restricted to iron. On the contrary, numerous materials with a correspondingly high magnetic permeability also come into consideration for this, for example, alloys that contain iron and nickel, that is, alloys that, in addition, are very advantageous in terms of corrosion resistance.

Suitable, beyond this, as materials for the keeper 46 or 48 and the keeper part 50 or 51 are, for example, soft magnetic ferrites, such as, for example, manganese-zinc ferrite, which offer a number of advantages. During their manufacture (for example, by pressing of the powdered starting material), they can be brought already into their desired form – for example, a keeper corresponding to Fig. 8c – and are therefore cost-effective both in this respect and in terms of the material and, as oxide ceramic materials, they are very resistant to corrosion. Added to this is their low density, that is, their low weight.

The details given on the construction of the magnet system, particularly with respect to materials and working substances for the fastening arrangement – in particular for permanent magnets, keeper parts, and keepers – in connection with individual sample embodiments do not mean that these cannot be employed as well in other sample embodiments.

Schematically depicted in Fig. 12, as also in Fig. 7, as seen from a front view, is once again the corrective spectacles 2 with rims 4 and 6, hinge tabs 8 and 10, and spectacle lenses 18 and 20. However, in place of the light shades 22, a corrective attachment 56 with the lenses 58 and 60 is fastened to the corrective spectacles 2 as accessory part in the case of the sample embodiment corresponding to Fig. 12, whereby the corrective attachment preferably exhibits a connecting part 62, corresponding to the connecting part 28, with, for example, a permanent magnet (not depicted), corresponding to the permanent magnet 36 of Fig. 7, and, as before, the bridge, corresponding, for example to the permanent magnet 34 in Fig. 7. There is no limitation here. On the contrary, all sample embodiments for the fastening arrangement given above in connection with the fastening arrangement for the light shades 22, in particular also with respect to its magnet system, can also be employed for the fastening arrangement of the corrective attachment 56 and other accessory parts. In this way, it is possible, for example, to construct, in an advantageous manner, a modular spectacle system from one or more corrective spectacles 2, light shades 22, corrective attachment 56, and other accessory parts through mutual compatibility.

The lenses 58 and 60 are made, preferably, from plastic glass that may be worked through injection molding techniques and / or by hot stamping, but they can also be made from other glass, particularly silicate glass – in particular if they are to exhibit an especially high refractive power or a short focal distance – whereby, in this case, the corrective attachment 56 (not depicted) has parts for holding the lenses 58, 60.

In the case of plastic glass, the corrective attachment 56, corresponding to the light shades 22 and including the connecting part 62, is fabricated especially advantageously as a plastic part by injection molding techniques, whereby, for example, the permanent magnet of the connecting part 62 can be co-formed at least in part by injection molding. In order to increase the mechanical stability, the corrective attachment 56 preferably has at least partially reinforced rim regions 65 and / or 67, which are highlighted in Fig. 12 by thick lines.

Corresponding to the regions 24 and 26 of the light shades 22, the corrective attachment 56 preferably has regions 64 and 66, projecting above and below, somewhat over the bridge 16 (not depicted in Fig. 12), which serve as a gripping means in attaching and detaching the corrective attachment 56 in this case.

In special cases – for example, when the corrective attachment is intended to have, at the same time, a light-shade effect, in particular for the protection of eyes against glare and / or irritation, and, in addition, an increased light-subduing effect, which can also involve the

nonvisible region of light – it is preferably designed as corrective attachment 68 with the lens regions 70 and 72 and the connecting part 69 (scheme, Fig. 13), which can be produced in an especially advantageous manner by, for example, injection molding techniques during the fabrication of the corrective attachment 68 and / or by hot stamping.

An accessory part in the form of a corrective attachment 56 or 68, which can be fastened quickly to an ophthalmic device – for example, corrective spectacles 2 in the case of Fig. 12 and Fig. 13 – is quite especially of practical importance for the large number of people with defective vision, who, in order to see distant and near objects in focus, require so-called multifocal glasses (multifocal lenses), for example bifocal glasses with two regions having different refractive power or focal distance: an upper one referred as a distant-vision part and a lower one referred to as near-vision part. The near-vision part is generally smaller than the distant-vision part and, in the case of far-sightedness, has an enhanced refractive power or a shorter focal distance than does the distant-vision part, so that the near-vision part enables sharper vision in the near range and the distant-vision part enables sharper vision in the distant range.

The term "glasses" employed in the framework of the present invention does not represent any limitation, in particular not in the sense of mineral or silicate glasses. On the contrary, plastic glasses, for example, are also understand under this term.

Fig. 14 shows schematically a further accessory part that facilitates the operation described in the preceding. This accessory part has, as auxiliary device 74, as indicated schematically in the view in the left part of Fig. 14, a region 76, which corresponds to the bridge 16 magnetically and in terms of dimensions, so that – compatible with the corrective spectacles 2 – the corrective attachment 56 or 68 can be fastened to the auxiliary device 74. The auxiliary device 74 has a means of attachment to objects of clothing, 75 – in Fig. 14, a pin, for example. If the auxiliary device 74 is worn on an object of clothing, then the corrective part can be fastened to it quickly and conveniently when it is not needed and removed from it quickly and conveniently when it is needed in order to fasten it to the corrective spectacles 2. Naturally, the pair of corrective spectacles 2 itself, as well as other accessories, such as, for example, the light shades 22, can also be reversibly fastened to the auxiliary device.

Of particular practical importance are also sample embodiments in which the means 75 for attachment to objects of clothing is replaced by a means for attachment to fixed objects, for example to dashboards by means of, for example, an adhesive layer (not depicted).

A further accessory part for the corrective spectacles 2, which can be fastened quickly and reversibly to the corrective spectacles 2 by means of the fastening arrangement in accordance with the invention and which is of particular importance in the area of work safety, is shown, as a sample embodiment, by the schematic depiction of Fig. 15, corresponding to the sectional depiction of Fig. 7, whereby, now, in place of the light shades 22 or the corrective attachment 56 or 68, a completely or partially clear protective part 78 with an connecting part 79 with a permanent magnet 77 is present for protection,

for example, against grinding shavings or sparks. Naturally, the protective part 78 can also exhibit an enhanced light-subduing effect and thus act simultaneously as light shades, in particular, for example, during welding, as well as light shades in, for example, the field of sports, whereby the light shades serve, in particular, for the protection of the eyes against glare and / or irritation and can involve protection against the nonvisible region of light as well – for example the ultraviolet region.

Whereas the above-described sample embodiments for the inclusion of ophthalmic devices and accessory parts in the fastening arrangement in accordance with the invention assumed corrective spectacles as the ophthalmic device, Fig. 16 shows schematically a sample embodiment in which, as ophthalmic device, eye or face protection in the form of so-called ski goggles 80 is assumed. Fig. 16, top, shows schematically a front view. Fig. 16, bottom, shows a section B-B, whereby parts situated behind the – transparent – window 84 are also depicted.

In Fig. 16 is depicted schematically, as sample embodiment for an accessory part, light shades 82, which, for example, are fabricated as a continuous light-subduing plastic part. The light shades 82 serve, in particular, for the protection of the eyes against glare and / or irritation, whereby the protection can also involve the nonvisible region of light, in particular, for example, the ultraviolet region. The light shades 82 are preferably fastened to the inside of a single-walled or multiwalled window 84, which is situated in a frame 85. In addition, permanent magnets 88 or 92 or parts 87, 89 in which they are at least partially situated, are attached to the window 84 by means of adhesive layers 86 or 90, respectively. The light shades 82 have the connecting parts 94 and 96, which they can advantageously be fabricated together with in an injection molding operation, whereby the permanent magnets 98 and 100, respectively oppositely poled to the permanent magnets 88 and 92, are situated in the connecting parts 94 and 96, respectively.

The similarity of the two magnet systems to the permanent magnets 88 and 98 or 92 and 100 of the sample embodiment corresponding to Fig. 16 does not signify any limitation. On the contrary, when several magnet systems are used, magnet systems differing from one another – for example, with and without keeper part 50 or 51 – can also be employed for the fastening arrangement for accessories to ophthalmic devices.

The connecting parts 94, 96 and the parts 87, 89 preferably have angled pieces 95, 102 and 97,104, respectively, as a means for self-adjusting fastening, assuring a firm sit of the permanent magnets 98 and 100 or of their connecting parts 94 and 96 to the permanent magnets 88 and 92 or to the parts 87, 89 and thus of the light shades 82 to the window 84.

The projecting regions 108 and 110, as a sample embodiment, serve as a gripping aid for the quick fastening and quick removal of the light shades 82. An elastic band 106 serves for holding them to the head.

In place of the light shades 82, it is possible to have, for example, a corrective attachment (not depicted) – for example, for the distant region in the case of near-sightedness – and

also a combination of both is possible, either by tinting of the corrective attachment or by simultaneous fastening of light shades and corrective attachment, given a corresponding design of the connecting part (not depicted).

Schematically depicted in Fig. 17, as ophthalmic device, are so-called diving goggles as viewed from the front, whereby parts fastened behind the – transparent – window 128 are also depicted, and as viewed through section C-C. Naturally, a corrective attachment 114 with lenses 116 and 118 is of particular practical interest here as accessory part.

In order to keep the visual obstruction due to the fastening arrangement as small as possible and to ensure a high fastening security corresponding to the requirements, the fastening arrangements in the sample embodiment in accordance with Fig. 17 are attached preferably in the side region of the ophthalmic devices at the edge of the facial field – corresponding also to the sample embodiment with the ski goggles in Fig. 16.

In addition, in the sample embodiment of Fig. 17, permanent magnets 124 and 126 or parts 121, 123 in which they are situated at least partially are attached by means of, for example, adhesive layers 120 and 122, to the window 128, which is situated in a frame 129. The corrective attachment 114 has connecting parts 130 and 132, with which it can be fabricated in an advantageous manner in one injection molding operation when plastic glasses are used. In the connecting parts 130 and 132 are situated the permanent magnets 134 and 136, respectively oppositely poled to the permanent magnets 124 and 126. In order to increase the mechanical stability, the corrective attachment 114 preferably has at least partially reinforced rim regions 117 (highlighted in Fig. 17 by thick lines).

The connecting parts 130, 132 and the parts 121, 123 preferably have angled pieces 137, 138 and 139,140 as a means for self-adjusting fastening, ensuring a firm sit of the permanent magnets 134 and 136 or of their connecting parts 130 and 132 to the permanent magnets 124 and 126 and thus of the corrective attachment 114 to the window 128.

The projecting regions 142 and 144, as a sample embodiment, serve as a gripping aid for the quick fastening and the quick removal of the corrective attachment 114. An elastic band 146 serves for holding the goggles to the head and a rubber insert 147 serves for watertightness.

Similarly to the ski goggles 80, further fastening possibilities are presented – for example, fastening of a further corrective attachment for the realization of the near zone in the case of defective vision requiring multifocal glasses (multifocal lenses; not depicted).

It is also possible, in particular in the case of far-sighted persons, to fasten a corrective attachment for the near region alone – in the lower region of the visual field – or, in particular for short-sighted persons, a corrective attachment for the distant region alone – in the upper region of the visual field – to the window 128.

In place of the ski goggles 80 or the diving goggles 112, it is also possible to use the same sample embodiments for accessory parts for similarly designed work safety glasses 113, this being indicated by the reference 113 included, in addition to the reference 80 for ski goggles, in Fig. 10.

The sample embodiments described above with the light shades 22, 82 as well as the corrective attachments 56, 68, 114, which each have the optically active elements for the path of light rays for both eyes, do not signify any limitation. On the contrary, these elements – for example, the lenses 58 and 60 or 70 and 72 and lenses that can also deviate strongly from these in their form – can also be fastened separately to the ophthalmic device by integration with the fastening arrangement of the invention – for example, corrective lenses behind the safety glasses of welding goggles (not depicted).

In the sample embodiments described above in accordance with Fig. 6 to Fig. 17 for the fastening of accessory parts with permanent magnets in accordance with the invention, there is no limitation.

On the contrary, the ophthalmic devices can also include, for example, spectacle frames without glasses. Furthermore, in a very advantageous way, it is possible to design the corrective spectacles 2 simultaneously to be light shade spectacles by providing their glasses 18, 20 with an increased light-subduing effect – for example, by tinting.

However, it is also possible to have pure light-shade spectacles in place of corrective spectacles 2, in a way that is very advantageous for the user, by designing their glasses 18, 20 without intended corrective effect and merely protecting the eyes of the user against light through enhanced subduing of light, whereby, due to the spectacle frame and the glasses, a certain protection of the eyes is also afforded against mechanical influences. It is also possible to employ, in a way that is very advantageous for the user, the accessory parts described in the above-described sample embodiments in accordance with Fig. 6 to Fig. 17, whereby, for example when the light shades 22 are fastened to light-shade spectacles, the light-subduing effect or the light-shade effect can be enhanced and / or the color transmitted can be changed – for example, from blue to green with light shades 22 whose translucent color is yellow. It has further proven of particular practical advantage to design the light-subduing effect of glasses of light-shade spectacles having permanent magnets in accordance with the invention in such a way that it decreases from the top down and to design the light-subduing effect of glasses of light shades 22 in such a way that it increases from the top down, so that, when fastened, the glasses afford a uniform, relatively strong light-subduing optical effect.

Of great advantage as an accessory part having permanent magnets in accordance with the invention, in particular for near-sighted persons, is a corrective attachment for the distant region, which can be fastened, for example, to the light-shade spectacles by means of the permanent magnets of the invention in such a way that its (negative) refractive power acts in the upper region of the visual field.

The light shades 22 can be designed advantageously for motor vehicle drivers in the known way as glare protection for motor vehicle drivers.

Furthermore, it is possible in an especially advantageous manner to attach to ophthalmic devices, by means of the permanent magnets in accordance with the invention, accessories that, when fastened, are situated largely outside of the optical path of the light rays, such as, for example, receptacles for the temporary storage of volatile substances, in particular perfumes, jewelry and / or decorative elements, hearing-protection pieces for introduction into the ears, fitted ear pieces of hearing aids, wire cord holders, lamps, and electronic and / or electroacoustic units, such as, for example, hearing aids, radio transmitters and / or receivers, measuring devices (for example, for radioactive radiation), and earphones, whereby the fastening of such accessory parts can occur, in particular, to the skull temples of the spectacles as well.

Claims

1. Fastening arrangement for the fastening of accessories to an ophthalmic device by means of at least one permanent magnet, characterized by the fact that at least one of the permanent magnets (034, 036; 34, 36; 52; 53, 54; 77; 88, 92, 98, 100; 124, 126, 134, 136) contains at least one rare earth element and / or cobalt.

2. Fastening arrangement in accordance with Claim 1, characterized by the fact that one or more of the permanent magnets in accordance with Claim 1 exhibits a magnetic anisotropy, whereby the preferred axes (38, 40) of several magnets, associated with the magnetic anisotropy, are oriented roughly parallel to one another.

3. Fastening arrangement in accordance with one of Claims 1 and 2, characterized by the fact that at least one of the permanent magnets in accordance with one of Claims 1 and 2 has a keeper (046, 048; 46, 68).

4. Fastening arrangement in accordance with one of Claims 1 to 3, characterized by the fact that the ratio (L/D) of the total length (L = L1 + L2) to the thickness (D) of the permanent magnets in accordance with one of Claims 1 to 3 is roughly in the range of the numerical values 1 to 3, inclusive of the range limits.

5. Fastening arrangement in accordance with one of Claims 1 to 4, characterized by the fact that the separation (h) between the permanent magnets (034, 036; 34, 36; 52; 53, 54; 77; 88, 98, 92, 100; 124, 134, 126, 136) in the fastened state is smaller than or equal to about 1/6 of their total length (L = L1 + L2).

6.. Fastening arrangement in accordance with one of Claims 1 to 5, characterized by the fact that at least one of the permanent magnets in accordance with one of Claims 1 to 4 is reversibly fastened opposite to a keeper part (50, 51) when an accessory in accordance with Claim 1 is fastened to the ophthalmic device in accordance with Claim 1.

7.. Fastening arrangement in accordance with one of Claims 1 to 6, characterized by the fact that at least one permanent magnet in accordance with one of Claims 1 to 5 or at least one keeper part (50, 51) is attached in the region of the bridge (016; 017; 16) and / or of a connecting part (28; 62; 69; 79; 94, 96; 130,132).

8.. Fastening arrangement in accordance with one of Claims 1 to 7, characterized by the fact that at least one ophthalmic device in accordance with Claim 1 and at least one accessory in accordance with Claim 1 has a means (42, 44; 95, 97, 102, 104; 137, 138, 139, 140) for firm seating and / or self-adjusting fastening of the at least one accessory part to the at least one ophthalmic device.

9.. Fastening arrangement in accordance with one of Claims 1 to 8, characterized by the fact that the ophthalmic device in accordance with Claim 1 is designed as a glassless spectacle frame or as corrective spectacles (2) or as light-shade spectacles or as corrective and light-shade spectacles or as work safety glasses (113) or as ski goggles (80) or as

diving goggles (112) and the accessory in accordance with Claim 1 has at least one pair of light shades (22) and / or at least one corrective attachment (56; 68; 114) and / or at least one protective part (78) and / or at least one auxiliary device (74) as holder for at least one accessory part and / or at least one glare protection for motor vehicle drivers and / or at least one receptacle for temporary storage of volatile substances and or at least one jewelry and / or decorative element and / or at least one hearing protection piece and / or at least one fitted ear piece of a hearing aid and / or at least one lamp and / or at least one electronic unit and / or at least one earphone.

Fig. 1
Fig. 1
Fig. 3
Fig. 4
Fig. 5
Fig. 6
Fig. 7
Fig. 8
Fig. 9
Fig. 10
Fig. 11
Fig. 12
Fig. 13
Fig. 14
Fig. 15
Fig. 16
Fig. 17

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This is to certify that the attached translation is a true and correct rendition into English of the German-language transcription of the international patent application to the best of my knowledge and belief.

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